DEVELOPMENT OF ROUGH GRINDING EQUIPMENT FOR RAW BIOMASS RESOURCE

MUHAMMAD HAIKAL B. ABDULLAH

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Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

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ABSTRACT

This researchdeals with the development of rough grinding equipment for raw biomass resource.Significant of this project is to provide equipment to grind the raw biomass materials and produce standard size of particle materials. The objective of this thesis is to develop grinding machine for raw biomass and to fabricate a grinding machine for raw biomass. The thesis describes finite element analysis techniques to predict the displacement magnitude and identify the worst stress locates in the structures. The structural of three-dimensional solid modeling of the machine grinding was developed using Solidworks software. The strategy of validation of finite element model was developed. The finite element analysis was then performed using SolidWorks Simulation. The machine grinding for biomass structure was analyzed using the static stress with linear material models approaches. The result of simulation show the minimum factor of safety is greater than 1 which means this frame and shaft machine grinding is in safe condition. In fabrication process,the machine grinding will be fabricated based on the design has been made. Fabrication process has involves mechanical processes such as grinding, drilling, cutting, milling and etc. Test run on the machine grinding will be done after all process had been completed to get the standard size of particles from output materials. As a conclusion, the development of rough grinding equipment for raw biomass resource was been developed and the result of the simulation and output materials from machine grinding show the positive result.

ABSTRAK

Kajian ini berkaitan dengan pembangunan peralatan pengisaran kasar bagi sumber biomas mentah. Penting projek ini adalah untuk menyediakan peralatan untuk mengisar bahan-bahan mentah biomas dan menghasilkan saiz standard bahan zarah. Objektif projek ini adalah untuk membangunkan mesin penggiling bagi biomas mentah dan untuk membangunkan mesin pengisaran untuk biojisim mentah. Tesis menerangkan terhingga teknik analisis unsur untuk meramalkan magnitud anjakan dan mengenal pasti menempatkan tekanan paling teruk dalam struktur. Struktur model tiga dimensi yang kukuh mesin pengisaran telah dibangunkan menggunakan perisian Solidworks. Strategi pengesahan model unsur terhingga telah dibangunkan. Analisis unsur terhingga kemudian dilakukan dengan menggunakan Solidworks Simulasi. Mesin pengisaran untuk struktur biomas telah dianalisis dengan menggunakan tekanan statik dengan model linear pendekatan material. Hasil simulasi menunjukkan faktor keselamatan minimum adalah lebih besar daripada 1, yang bermakna bingkai dan aci ini mesin pengisaran adalah dalam keadaan selamat. Dalam proses fabrikasi, mesin pengisar akan direka berdasarkan reka bentuk yang telah dibuat. Proses fabrikasi telah melibatkan proses mekanikal seperti mengisar, menggerudi, memotong, pengilangan dan lain-lain Ujian dijalankan pada mesin pengisar akan dilakukan selepas semua proses telah selesai untuk mendapatkan saiz yang standard zarah daripada bahan-bahan keluaran. Kesimpulannya, pembangunan peralatan pengisaran kasar bagi sumber biomas mentah telah dibangunkan dan hasil daripada bahan-bahan simulasi dan pengeluaran dari mesin penggiling menunjukkan hasil yang positif.

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T	Torque
P_{hp}	Power
n	Revolution per minute
F	Force
r	Radius of sprocket

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Renewable energy is of growing importance in satisfying environmental concerns over fossil fuel usage. These can provide the only source of renewable liquid, gaseous and solid fuels. Biomass is considered the renewable energy source with the highest potential to contribute to the energy needs of modern society for both the developed and developing economies worldwide. Biomass resources include various natural and derived materials, such as woody and herbaceous species, wood wastes, bagasse, agricultural and industrial residues, waste paper, municipal solid waste, sawdust, bio solids, grass, waste from food processing, animal wastes, aquatic plants and algae etc. Recently, owing to environmental and economic considerations, interest in utilizing biomass for the production of energy and chemicals is increasing.

Malaysia as the largest producer of palm oil in the world generates a significant amount of oil palm wastes. This is true in the cases of some other Asean countries as well. According to a study by (Yatim 2003), Malaysia generates 7.7 million tonnes of empty fruit bunches (EFB) 6.0 million tonnes of fiber and 2.4 million tonnes of palm shell every year as wastes. EFB are not considered for fuel because of its high moisture content (65%). The fiber wastes are used to generate energy to run the palm oil mill by incinerating the waste for power and fertilizer purposes.

According to (Ngan and Ang, 2001), it must be emphasized that palm oil mills generally have excess fiber and shell which are not used and have to be disposed off separately. There are more than 270 palm oil mills operating in Malaysia that utilize mainly fiber and partly shell in their boilers as fuel to generate power and steam required by the industry. The fiber is fully required in the mill for this purpose. However, only about 30% of shell is utilized for this purpose (Shamsuddin, 2004). Besides, the present utilization of this palm waste as boiler fuel is creating a serious emission problem in the industry.

From a recent study conducted by (Rozaineel,2000), it appears that more than 80% of the boilers emit particles exceeding 0.4 g Nm-3, the permissible limit set by the Department Of Environment. The study showed that the range of emission varied from 0.25 to 3.73 gNm^{-3} From another study by (Yusofel, 2000), it was found that the boilers, using palm waste as fuel at palm oil mills, are producing very much higher levels of dust emission of up to 11.6 gNm^{-3} compared to the allowable limit of 0.4 g Nm-3 causing a serious environmental problem.

Thus, it is important to find some ways and means to use these wastes in a mannerthat does not pollute the environment and at the same time, provide improved materials and energy. It is currently widely acknowledged that the most ecologically sound way to treat a worn-out waste product is pyrolysis.

1.2 PROBLEM STATEMENTS

Generally, it is accepted worldwide that climate change is currently the most pressing global environmental problem facing humanity. Scientific data showed that hundreds of millions of people could lose their lives if the average global temperatures increase by more than2°C. In addition, up to one million species of animals and plants are currently at the threat of extinction. Use a palm oil as bio fuel and biomass energy.

The Fourth Assessment Report (AR4) which was released on 17 December 2007 of the United Nation Inter governmental Panel on Climate Change (IPCC) concluded that the observed warming over the last 50 years is likely due to the increase of green house gas emission such as carbon dioxide, methane and nitrous oxide (Hopwood et al, 2000). Nevertheless, carbon dioxide has been identified as the main culprit due to its huge emission and therefore, utilization of fossil fuel as a source of energy for heat, electricity and transportation fuel have been identified as the primary cause of global warming.

Besides that, from considering the current state of energy crisis with the price of crude petroleum hitting record high every other day. Apart from that, its utilization as a source of energy will bring other environmental benefit like reduction in CO_2 emissions. This problem can be overcome since oil palm biomass can be used as alternative fuel in the power generation meanwhile bio-ethanol and bio-methanol can be used as vehicles fuel.

The grinding is one of the methods for processing biomaterials, very little is known about optimizing the process based on the mechanical properties of the material to be ground.So to implement,grinding equipmentfor raw biomass material fuelis required tobedeveloped.

1.3 OBJECTIVES

The objective for this project is as following:

a. To develop grinding machine for raw biomass.
b. To fabricate a grinding machine for raw biomass.

1.4 SCOPES

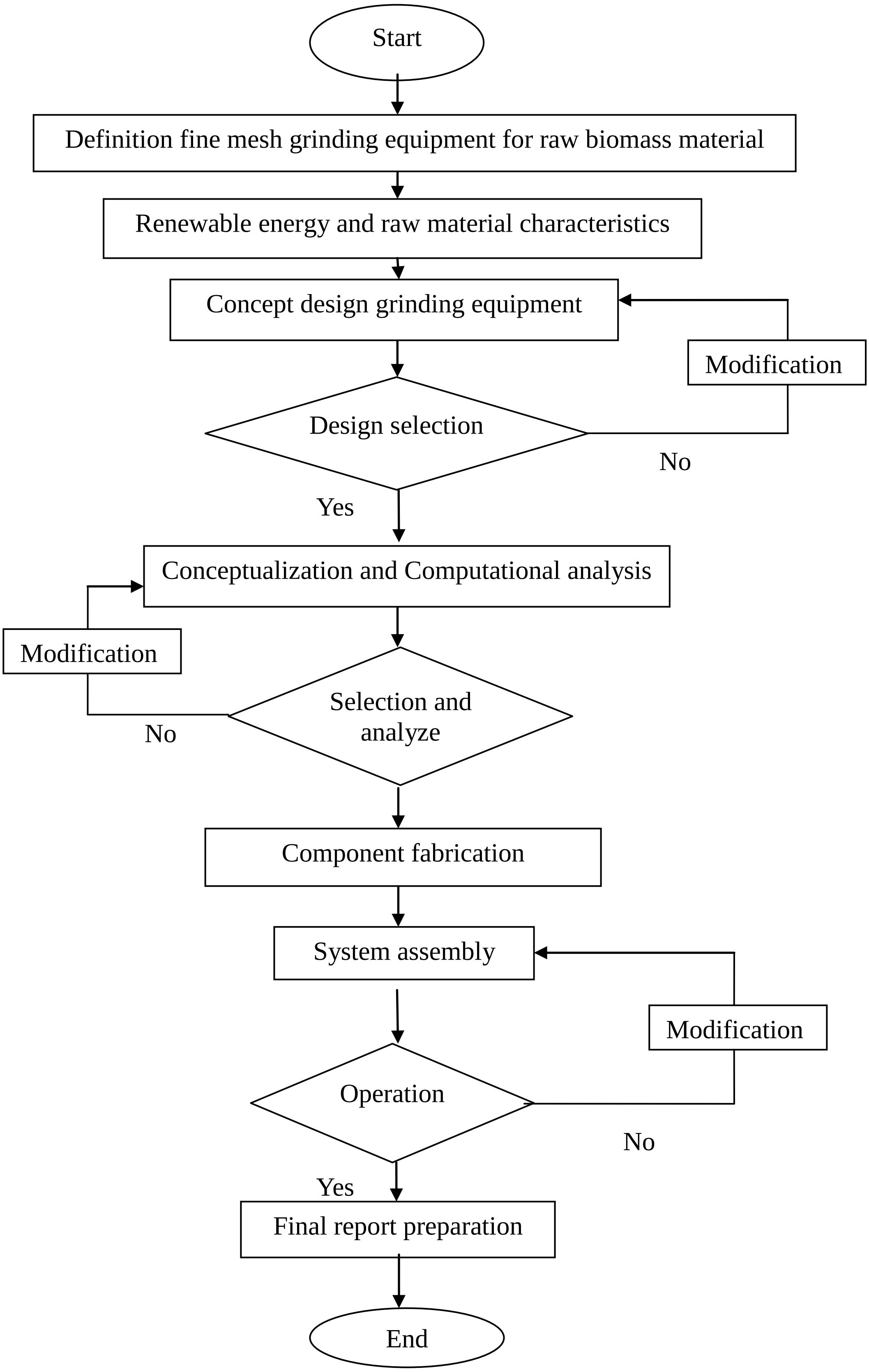
This scope for this project is as following:

a. Development of model grinding for raw material biomass using solid works.
b. Development and fabrication for grinding for raw material biomass.
c. Computational analysis on fabrication model.
d. Working model.
e. Final report preparation.

1.5 HYPOTHESES

Rough grinding equipment for raw biomass resourcecouldachieve allaspectsin design considerationwhichisfunctionalityandtheabilityof themachine grinding.Bytheend of thedevelopment,machine grinding will working and able to grind raw biomass resource.

1.6 FLOW CHART



1.7 GANTT CHART (ReferAppendix A)

CHAPTER 2

LITERATURE REVIEW

2.1 RENEWABLE ENERGY SOURCE (RES)

A renewable energy source (RES) can be defined as a simple sustainable resource available over the long term at a reasonable cost that can be used for any task without negative effects. Other authors consider RESs as clean sources of energy and that the optimal use of these resources minimizes environmental impacts produces minimum secondary wastes and is sustainable based on current and future economic and social needs (NL Panwar et al, 2011). Positive points in the use of RESs are the increased diversity in energy supply options, both for developed and developing countries (PD. Lund, 2009), less dependence on fossil fuels, the increase of net employment, the creation of export markets and a reduction in greenhouse gas emissions and climate change (R Sims, 2003)

Renewable energy takes on many forms, and usually describes using natural resources that won’t run out. There are several main renewable energy technologies in use, most of which are directly or indirectly due to the sun such as wind turbine, solar power and power generation from sea wave. But these kinds of renewable energy is not commercially used and based on geography of certain places for example, in sunny climates, it makes more sense to create renewable energy from solar panels, whereas in coastal areas, it may be more efficient and effective to use wave or tidal power.Three Gorges dam, the largest renewable electricity source in the world, having displaced 1.3 million people, (Lin Yang, 2007) and garnered environmental criticism.

To overcome these, biomass seems be more promising as a source of renewable energy as it is more reliable and sustainable source. Biomass can be found anywhere and can be replaced. As the need for alternative forms of energy become more important, biomass can play a bigger part for the production of fuel and electricity generations.

2.2 BIOMASS

Biomass refers to living and recently dead biological material that can be used as fuel or for industrial production. Most commonly, biomass refers to plant matter grown to generate electricity or produce bio fuel, but it also includes plant or animal matter used for production of fibers, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel. Fossil fuels such as coal and oil are not considered to be biomass as they are not recently dead, nor were they produced especially to become biomass.

Biomass is carbon based and is composed of a mixture of organic molecules containing hydrogen, usually including atoms of oxygen, often nitrogen and also small quantities of other atoms, including alkali, alkaline earth and heavy metals. These metals are often found in functional molecules such as the porphyrins which include chlorophyll which contains magnesium. The carbon used to construct biomass is absorbed from the atmosphere as carbon dioxide CO_2 by plant life, using energy from the sun. Plants may subsequently be eaten by animals and thus converted into animal biomass. However the primary absorption is performed by plants. If plant material is not eaten it is generally either broken down by microorganisms or burned.

If broken down it releases the carbon back to the atmosphere, mainly as either carbon dioxide CO_2or methane CH_4, depending upon the conditions and processes involved. If burned the carbon is returned to the atmosphere as CO_2.These processes have happened for as long as there have been plants on Earth and is part of what is known as the carbon cycle.

2.3 SOURCES OF BIOMASS IN MALAYSIA

Malaysia is bestowed with significant of biomass resources. The agriculture and forestry sectors produce a large amount of residues from oil palm, wood, rubber tree and rice that has no other commercial values then potential energy generation. In addition, urban waste and some animal waste can be used to generate energy. The existence of the waste and residues has created some disposal problem to the country.

A large portion of renewable resource is contributed by biomass, namely oil palm waste, and wood waste, which are used to produce steam for processing activities and also for generating electricity. Biomass fuel contributed to about 16% of energy consumption in the country, out of which 51% come from palm oil biomass waste and 27%, wood wastes. Other biomass energy contributors are from plant cultivations, animal and urban waste. There are currently more than 300 palm oil mills in operation, which self generates electricity from oil palm waste not only for their internal consumption but also for surrounding remote areas.

Palm oil is one of the world's most rapidly expanding equatorial crops. Indonesia and Malaysia are the two east oil palm producing countries and is rich with numerous endemic, forest-dwelling species. Malaysia has a tropical climate and is prosperous in natural resources. Oil palm currently occupies the largest acreage of farmed land in Malaysia (Tengku Mohd Ariff et al, 2001). The oil palm is grown for its oil and other part something valuable. Through certain process palm oil and palm kernel oil are extracting from monocarp and kernels respectively. In general, fresh fruit bunches contain 27 % palm oil by weight, 6-7% palm kernel, 14-15% fiber, 6-7% shell and 23% empty fruit bunch (EFB) material. The energy generating of oil palm comes from processing by-products, replanting residues and palm oil mil effluents (POME). The biomass from POM is burned in the boiler that produces process steam and electricity in a cogeneration system.

Malaysia is one of the major wood processing countries in the region. Wood are currently the largest renewable energy potential in the country. The greatest potential for developing wood as a source of energy is to use wood residues that have no other commercial values. Peninsular Malaysia is currently harvesting about 1.2 million tons per year of log. This amount is estimated to have 18 trillion joules of energy. However, this only represents 60 to 65 % of total harvested trees. The remaining percentage is left to rot or burn.

Malaysia is one of the biggest rubber producers in the world. Replanting and conversing of rubber land is the important source of rubber wood. Rubber wood has been used for fuelling various drying process such as smoking rubber sheet, drying cocoa beans and also drying and curing of wood as well as drying bricks. Since rubber wood becomes popular in furniture industries, the use as fuel has declined.

Waste generated rubber industry can be classified as coming from three sources. The first one is the biomass generated from fallen leaves, branches and twigs as well as rubber seeds. Most of this biomass is being left to root on the plantation ground, even though some branches and twigs are used for domestic fuel. The second source consists of effluents that are produce after processing of latex. The third sources of bio wastes, is rubber wood that become available in large quantities during replanting activities.

Paddy cultivation in Malaysia is concentrated in the state of Kedah and Selangor. The cultivation of paddy leave two type of residues: Paddy straw and rice husk. Even though the potential of biomass energy from paddy cultivation can be contributed quite a percentage of country demand, paddy waste is most difficult to handle. Furthermore, they only available during harvesting season that happen only 1 to 3 time a year.

Most of the sugarcane cultivation appears in the northern states of peninsular Malaysia where a dry season is distinct. Malaysia has to import about 600 000 tons of sugar every year to meet the demand.

In term of biomass energy, sugarcane cultivation produces granulated sugar, bagasse and dry leave and cane tops that can potentially be converted into useful energy.

Animal wastes in large amount can cause hazard to environment and health if not properly managed. Animal farming areas are places where high concentration of this waste accumulated. Some of these animals are concentrated over a small area such as poultry and goat.

The oil palm industry in Malaysia started 80 years ago in a modest way. Today it is the largest in agricultural plantation sector, exceeding rubber plantation by more than double in area planted. Based on the researched from the World Wildlife Fund (WWF), Malaysia is currently the world's largest producer of palm oil, contributing of 50.9% of total global production. In terms of hectare, the total area under oil palm cultivation is over 2.65 millionhectares, producing over 8 million tonnes of oil annually. The oil consists of only 10% of the total biomes produced in the plantation. The remainder consists of huge amount oflignocelluloses materials such as oil palm fronds, trunks and empty fruit bunches.

2.4 TYPE OF GRINDING MACHINE

2.4.1 Hammer Mill Machine

A hammer mill (Schuttle Buffalo) with a 230 mm diameter rotor powered with a gasoline engine rated at 18 kW was used for grinding. The hammer mill rotor had sixteen swinging hammers in four sets pinned to its periphery. Length and thickness of each hammer were 178 and 6.4 mm, respectively. The performance of dull versus sharp hammers of same hammer thickness was investigated to explore whether any advantage could be realized by knife shear action, or whether the relative high velocity of impact dominated in the failure of fibrous biomass.

Hammer thickness of dull and sharp hammers were same to no introduce the variable hammer thickness into experiments. Previously, thin hammers performed better than thick hammers. Hammers tested included 90° (dull) and 30° (sharp) leading edges. An interchangeable classifying screen of 3.2 mm was mounted around the rotor.

Hammer clearance with screen was 5 mm. An engine rated speed of 3600 rpm powered the hammer mill at the same speed by using a V-groove pulley and belt drive system. Various engine throttle settings operated the hammer mill at speeds ranging from 2000 to 3600 rpm (5 levels) to examine speed effects. Corresponding tip speeds were 48 to 87 m/s, respectively. These speeds were within the range of commercial milling of agricultural products using hammer mills. Hammer mill bottom was connected to a dust collector maintaining a negative suction pressure of 60 mm of water to overcome air-flow resistance of 3.2 mm screen and biomass, to reduce dust losses, and to improve flow of input feed.

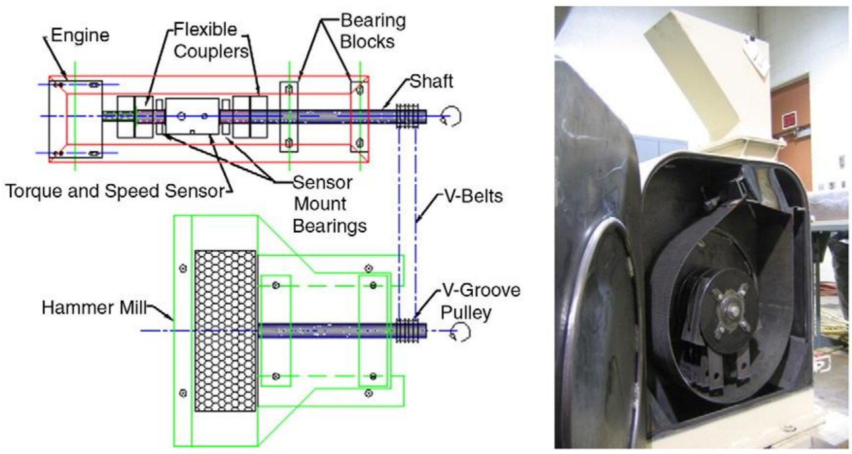


Figure 2.1: Overview of Hammer Mill Machine

Source: T. Yang el at(2007)

2.4.2 Knife Mill Machine

A commercial knife mill (H.C. Davis Sons Mfg.) with a 400 mm diameter rotor powered with a gasoline engine rated at 18 kW was used for chopping. The knife mill rotor had eight 75 mm-wide straight knife blades bolted to the rotor periphery. Length and thickness of single bevel edge blade were 600 and 12 mm, respectively. Knife blade lip angle was 45. Blades cleared two stationary shear bars indexed at about the 10 o’clock and 2 o’clock angular positions.

A uniform blade clearance of 3 mm was used. An interchangeable classifying screen was mounted in an arc of about 240 of angular rotation around the bottom side. Screen selections tested had opening diameters ranging from 12.7 to 50.8 mm (4 levels). An engine rated speed of 3600 rpm powered the knife mill at a speed of 507 rpm by using a V-groove pulley and belt drive system. Various engine throttle settings operated the knife mill at speeds ranging from 250 to 500 rpm (5 levels) to examine speed effects.

Figure2.2: Knife Mill Machine

Source: David R. Smith el al(2009)

2.4.3 Pin Mill Machine

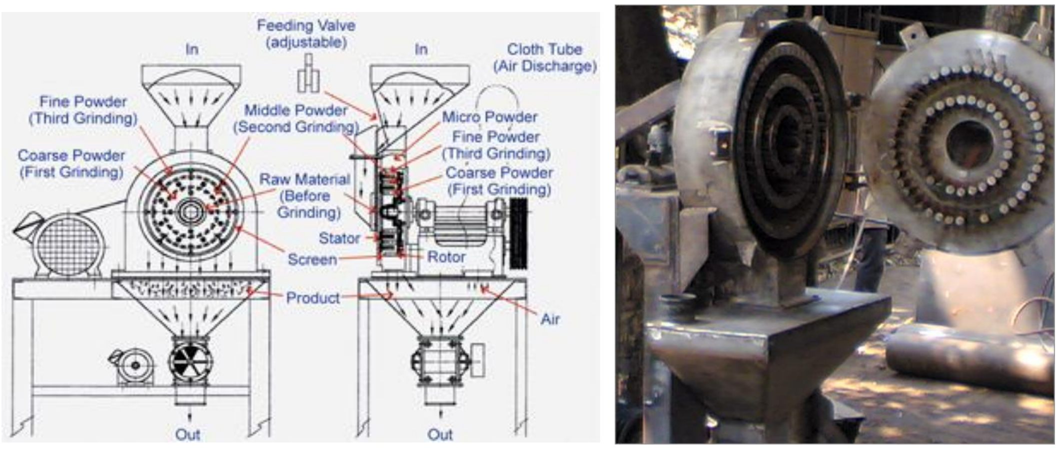


Figure2.3: Pin mill machine

Source: P. Bitrael et al (2007)

The grinding action within the Pin Mill is achieved by impacting the product particles with a series of hardened steel pins. Raw material is fed into the grinding chamber from the feeding hopper then passes through rows of pins rotating at high speed between stationary pins.

The first grinding is a shearing force created by the cutting impact of the inner rotor and stator. The product particles are shattered into fragments as they progress towards the outlet. This action creates a fan effect and a high volume of air is drawn through with the product, keeping it cool. After filtrating, any remaining coarser powder will be ground in the third grinding until it passes through the screen mesh. The finished product is discharged from the rotary valve. The machine’s grinding action can be controlled by altering the feed rate to the machine and the speed of the rotor.

2.4.4 Disk Mill Machine

A disc mill is a piece of equipment used for crushing or grinding. The disc mill consists of a series of steel plates, or discs, that rotate within a machine to crush stones, metal, or other materials. Depending on the type of material being crushed or ground, the discs may have smooth or serrated edges. Some even have blades or spikes attached to the discs for cutting and shredding.

Vibrating disc mills use high-speed vibration to separate items after they have been crushed or ground. For example, a vibrating disc mill may be used to remove the shell from seeds or nuts, then to automatically dispose of the shells so the nuts can be easily collected. Single-wheeled models consist of one disc that runs along a steel base to grind items, while a double-wheeled disc mill crushes items by grinding them between two interconnected plates.

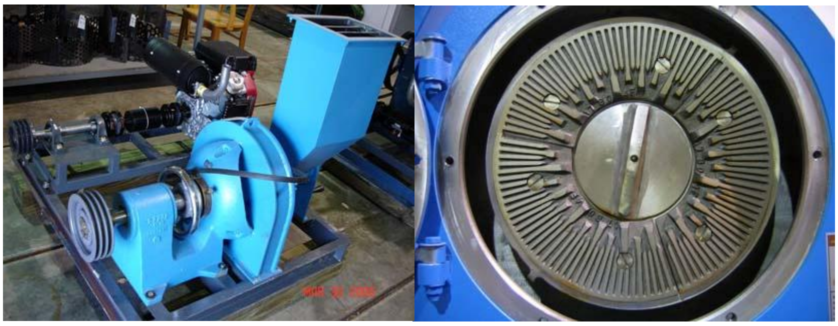


Figure 2.4: Disk mill machine

Source: T. Yang el al (2007)

2.5 GRINDING PROCESSES

(Austin, 1971) mathematically described grinding processes generally used for homogenous brittle materials. Topics included particle size distribution, differential equations describing particle breakage, and thee notion that grinding is a rate process dependent on some small period of time Δt. Continuous flow and batch grinding were considered.